U. S. FOREST SERVICE

RESEARCH NOTE LS-45

AKE STATES FOREST EXPERIMENT STATION • U. S. DEPARTMENT OF AGRICULTURE

Hourly Variation in Fire Danger in the Lake States

Rating forest fire danger by combining basic weather and fuel moisture measurements has been a standard operating procedure in all forest fire control agencies for nearly 30 years. Fire danger is rated by determining a numerical index that represents the burning conditions for a particular unit of land; the index is then used to assist in fire preparedness planning for more efficient expenditure of funds for fire control.

Recent fire research has been directed toward developing a Unified National System of Fire Danger Rating — that is, a uniform procedure on a nationwide basis for measuring and interpreting forest fire danger. Already completed is a Fire Spread Index designed to indicate the *relative* rate of fire spread in light and intermediate forest fuels. Yet to be developed are reliable indicators of risk, ignition probability, and fire intensity. When all these indexes are completed and combined, they will give a more complete picture of fire job load requirements.

To obtain adequate weather measurements for fire weather forecasting, the Unified National System requires that the official danger rating measurement should be taken near the time of average maximum Spread Index for the day. Fire weather observations should be made during the afternoon period of highest fire danger so that the most meaningful fire weather is recorded and made available to the fire weather forecaster for use in his forecast for the following day. Fire weather forecasts made by the Weather Bureau utilize temperature, relative humidity, and wind observations as well as other weather factors taken during the time of day when fires are most likely to start and spread.

The study reported here was undertaken to provide answers to two questions for the Lake States region: (1) On the average, what time of day does the highest fire danger occur, and (2) is it possible to use 1:00 p.m. (a convenient observation time) as the official time for the daily fire danger measurement?

To determine when the most severe fire weather conditions may be expected, hourly Spread Index values and wind velocity readings were summarized for the months of April, July, and October at four First Order Weather Bureau Climatological Stations. A 3-year period, 1961-1963, was used for April and July, and 2 years for October except at Grand Rapids, Mich., where 3 years was used. The four weather stations (International Falls and Minneapolis-St. Paul, Minn., LaCrosse, Wis., and Grand Rapids, Mich.) are representative of the daily trend in fire weather for the Lake States area. However, local fluctuations in wind, temperature, and relative humidity may produce a pattern of weather somewhat different than for any of the selected stations or for the region as a whole.

Fire spread index. — Spread Index for brush or timber fuel types is adjusted for cumulative drying conditions by means of the Buildup Index. However, for this study no adjustment for the buildup factor was made, so the Spread Index is related only to light surface fuels where fires may start easily and spread rapidly. Calculation of Spread Index was based on a fixed condition of vegetation (herbaceous stage) for each month and location. April and July were considered "cured" and "green" respectively. October was based on 20 days in "transition" and 11 days in the "cured" stage. Past records indicate that these are reasonable assumptions concerning the herbaceous stage of the vegetation.

Results show that average differences in Spread Index between the afternoon hours are small (table 1). Hence, fire danger conditions between 1 and 4 p.m. are, on the average, similar and represent the period of most severe fire weather for the day. Individual days may diverge considerably from this average daily pattern of fire weather.

Wind velocity. — Average hourly wind velocities for each of the four stations indicated only a 1 to 3 m.p.h. variation between the hours of 10 a.m. and 4 p.m., and average velocity remained nearly constant from 1 p.m. to 4 p.m. (table 2). The fact that Spread Index increased from morning to early afternoon while the average wind velocity showed little change demonstrates the importance of relative humidity on fine fuel moisture during

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TABLE 1. — *Average Spread Index from 10 a.m. to 4 p.m. standard time during April, July, and October at four locations in the Lakes States*[1]

Location	Month	Time of day							Standard error of mean
		10	11	12	1	2	3	4	
LaCrosse, Wis.	April	34	38	40	43	44	45	44	2.2
	July	12	15	18	19	18	19	19	.9
	October	19	23	28	30	31	32	30	2.1
Grand Rapids, Mich.	April	32	37	39	41	42	44	44	1.9
	July	14	16	17	19	19	20	20	.7
	October	18	22	27	30	30	30	29	1.4
Minneapolis, Minn.	April	30	32	36	39	40	39	38	2.1
	July	11	13	16	17	17	17	16	.8
	October	18	22	26	28	30	29	28	1.8
International Falls, Minn.	April	23	26	29	31	32	33	33	1.6
	July	11	12	14	15	16	15	14	.8
	October	13	18	22	24	25	24	24	1.6

[1] *Average Spread Index values are rounded off to the nearest whole number.*

TABLE 2. — *Average wind velocity from 10 a.m. to 4 p.m. standard time during April, July, and October at four locations in the Lake States*[1]

Location	Month	Time of day							Standard error of mean
		10	11	12	1	2	3	4	
LaCrosse, Wis.	April	13	14	15	15	15	16	15	.7
	July	9	10	11	11	11	11	12	.5
	October	12	12	13	13	13	13	12	.8
Grand Rapids, Mich.	April	13	14	14	14	14	14	14	.5
	July	9	10	10	11	11	12	12	.4
	October	10	11	11	12	12	12	11	.4
Minneapolis, Minn.	April	13	14	14	15	15	14	14	.6
	July	10	10	11	11	11	11	11	.5
	October	11	11	12	12	12	11	11	.6
International Falls, Minn.	April	10	11	11	12	12	12	12	.6
	July	8	9	9	10	9	9	8	.4
	October	9	9	10	10	11	10	10	.7

[1] *Average wind velocity values are rounded off to the nearest whole number.*

the same period. Thus, the average daily increase in fire danger was due primarily to a general lowering of relative humidity from morning to mid-afternoon.

Conclusion. — The hourly trend in *average* Spread Index for the four locations studied showed that fire danger conditions between 1 p.m. and 4 p.m. did not vary appreciably. To fire control agencies, this indicates that weather observations used for computing maximum daily Spread Index will be satisfactory when taken at 1 p.m. or near the end of the normal noon lunch hour when personnel at ranger district headquarters or other field stations are available.

April 1964

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